C. J. MERFIELD, Esq., of the Sydney Observatory, was a capable and busy member of our expedition during the eleven days that the British party was on the island.

Thanks are extended to Mr. McCLEAN for his generosity in transporting Mr. MERFIELD from Auckland to the island and return, and for the spirit of comradeship and good cheer which he and all the members of his party supplied.

It was a rare pleasure to have Professor LEWIS in our expedition.

The presence of Director ABBOT and Mr. MOORE, of the Smithsonian Institution Expedition, was at all times a happy arrangement. It was a great satisfaction to every member of our party that Mr. ABBOT's scientific plans were carried out exactly as planned.

I gladly acknowledge the able assistance of my colleagues, Messrs. PERRINE, AITKEN, and ALBRECHT, whose services were always available, both in the preparations and at the station. It has been the lot of Dr. PERRINE and myself to be associated in the observation of three eclipses. A veteran of five eclipses, he has no superior as an eclipse observer; and his services, placed unreservedly at my command, were held in high esteem.

A BOLOMETRIC STUDY OF THE SOLAR CORONA.

By C. G. ABBOT.

The Smithsonian Institution was represented among observers of the eclipse of January 3, 1908, by a small expedition including the writer and Mr. A. F. MOORE, of Los Angeles. Our charges were defrayed by the Institution, but we went by invitation and with the co-operation of Director CAMPBELL, of the Lick Observatory, and shared in the benefits of the careful provision which he made for the general welfare and success.

We proposed to measure, with that extremely sensitive electrical thermometer called the bolometer, the intensity of the radiation of the solar corona, and to determine the quality of coronal light as compared with sunlight.

STATION OF THE SMITHSONIAN INSTITUTION EXPEDITION.

In the year 1900 the first bolometric observations of the corona were made by Smithsonian observers. From these observations it was inferred that, as regards quality, the radiation of the inner corona was far richer than that reflected from the Moon in visible light. In view of this consideration and others, the inferences drawn by the writer from the bolometric study of the corona made in 1900 were unfavorable to the view that the radiation of the inner corona is produced mainly by the incandescence of matter heated to high temperatures by reason of its proximity to the Sun. The bolometric observations at Flint Island were designed to test the inferences above referred to and to measure more definitely the quantity and quality of the coronal radiation.

APPARATUS.

Referring to the accompanying illustration, a concave mirror of 50^{cm} diameter and only 100^{cm} focus, mounted equatorially and driven by a clock, served to produce a very intense image of the corona. A small guiding telescope was attached to the mirror frame so that the observer might point toward any desired object. In the focus of the mirror was placed the bolometer. A glass plate 3^{mm} thick was fixed close to the bolometer, between it and the mirror, so that the radiation examined was thereby limited to wave-lengths less than about 3μ. About 10^{cm} in front of the bolometer was a blackened metal shutter, which cut off the beam except when designedly opened. The opening of this shutter, therefore, exposed the central part of the bolometer to such rays as are transmissible by glass. Between the shutter and the glass plate, and close to the latter, was a special screen composed of a thin stratum of asphaltum varnish laid on one side of a plane parallel glass plate 3^{mm} thick. This screen was held out of the beam by a spring, except when designedly interposed. Its property, when used, was to cut off nearly all the visible part of the radiation, while transmitting nearly all of the infra-red rays transmissible by glass. By interposing this absorbing screen the proportion of the observed radiation which lay in the infra-red spectrum could be roughly determined.

The equatorial was set up at Flint Island on the beach at about 12^{m} distance from the galvanometer used for observing

the indications of the bolometer. Two galvanometers were provided, exactly alike in resistance and general construction, and arranged so that if at the last moment any accident should happen to one the observer might pass at once to the other.[1] A thatched hut, shaded by palm trees, sheltered the galvanometers and their appliances, and was found to give most satisfactory protection both from heat and rain. During the eclipse a rise of temperature of one bolometer strip of about $0^\circ.000,01$ C. would have produced 1^{mm} deflection of the galvanometer. It is possible to detect temperature changes of $0^\circ.000,000,01$ C. with the bolometer, under special conditions, but the sensitiveness employed was regarded as good for a temporary installation.

THE OBSERVATIONS.

The approach of totality was uncommonly exciting on this occasion. Early in the morning the sky was overcast with thin high clouds, but these gradually grew thinner, so that after 9 A. M. the prospects indicated a streaky sky, containing something almost too thick for haze, but almost too thin for cirrus clouds. These prospects were fulfilled exactly during totality, but in the quarter of an hour next preceding a thick cloud came up, rain fell fast from $11^h\ 8^m$ to $11^h\ 14^m$, and the sky became clear of the low cloud only fifteen seconds before totality at the Smithsonian station. The rapid change from fair prospects to completely discouraging ones, and the return to good conditions just at the critical time, will long be remembered. Our entire immunity from rain during totality was due to the fact that our station was about one thousand feet north of the one occupied by the Lick Observatory.

The intensity and quality of sunlight was determined within twenty-five minutes of totality, both before and after, and during totality measurements were made at five different regions of the corona and on the dark Moon. A general summary of the results of these and other observations follows:—

[1] This prudent measure was suggested by Mrs. ABBOT.

INTENSITY OF RAYS (OBSERVED THROUGH GLASS).

Source.	Intensity for unit angular area.
Sun near zenith, Flint Island......	10,000,000
Sky 20° from Sun, Flint Island....	140
Sky far from Sun, Flint Island....	31
Sky average, Flint Island.........	62
Sky average, Mt. Wilson, Cal......	15
Moon at night, Flint Island.......	12(?)
Moon during eclipse, Flint Island..	0
Corona 1/10 radius from Sun.....	13
Corona 1/4 radius from Sun.....	4
Corona 3/4 radius from Sun.....	0

PROPORTION OF RAYS WHICH ASPHALTUM TRANSMITS.

Source.	Determination. I.	II.	Mean (Weighted).
Sun 3/10 radius from limb..	0.333	0.331	0.332
Corona 1/10 radius from limb	0.343	0.384	0.364
Corona 1/4 radius from limb	0.387	0.323[1]	0.362
Moon at night............	....	....	0.5
Sky, zenith day............	....	....	0.23

DISCUSSION OF THE RESULTS.

When we recall the extreme brightness of the sky within a single degree of the Sun, as compared with that 20° away, and consider also the figures just given, it seems very unlikely that the corona will ever be observed without an eclipse.

The nature of the radiation of the inner corona has been supposed by some to be principally reflected solar radiation, by others to be principally due to the incandescence of particles heated by reason of their proximity to the Sun, by others to be principally luminescence perhaps similar to the Aurora, and by some as a combination of all of these kinds of radiation.

The spectrum of the corona is mainly continuous, but has some inconspicuous bright lines, and in its outer part has dark solar lines. Undoubtedly there is sunlight reflected by the matter of the corona, and no less surely the corona must be hot. As for the idea of luminescence by electrical discharge, though the streamers of the corona are a reminder of the Aurora, one hesitates to recommend an explanation involving

[1] This observation is entitled to only half the weight of the others.

a thing so little understood, so that we will here speak only of the incandescence and reflection of the corona as sources of its brightness. The bolometric results indicate that the coronal radiation differs but little in quality from that of the Sun, and is in fact far richer than the reflected rays of the Moon in visible light, although less rich than sky-light.

These results indicate that if produced by virtue of high temperature, the coronal radiation must have come from a source almost as hot as the Sun, which is upwards of 6000° absolute. Such temperatures as this are too high for the existence of any solids or liquids, unless under high pressures not found in the corona, so that if the light is due to the high temperature of the corona itself, the corona must be gaseous. But if it is gaseous, its spectrum should consist chiefly of bright lines, and this is not the fact. Hence, it would seem that the coronal radiation, if it is produced by temperature, has its cource in the Sun itself, and is merely reflected by the matter of the corona, like the light of our atmosphere. But if the coronal rays are reflected, they would be bluer than sunlight, if the material there is gaseous; and as they are not, the coronal material may be supposed to be composed of solid or liquid particles to a considerable extent. But it is objected that only the outer corona shows the characteristic dark lines of the solar spectrum, and that these are absent in the region of the corona now being considered. May it not be that the temperature of the inner corona is so high that gases are present there along with the solid and liquid particles, so that the bright-line spectrum of these gases may be present and be superposed upon the reflected solar spectrum? In this case, the bright rays of incandescence would fall exactly upon the dark lines of the solar spectrum, and tend to obliterate them. At points in the corona more remote from the Sun the gases would cool to liquid drops, or solid particles, or become excessively rare, so that the bright-line spectrum of incandescent gas would fade away, leaving the dark lines of the reflected solar spectrum predominant.

This line of explanation seems to me to accord with the facts observed, but I give it merely as a suggestion.

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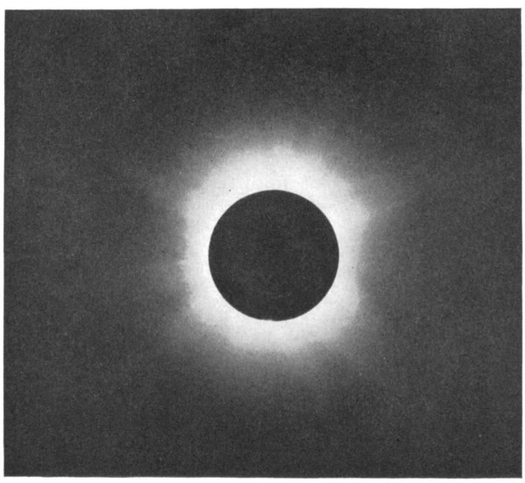

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THE SOLAR CORONA.
January 3, 1908.

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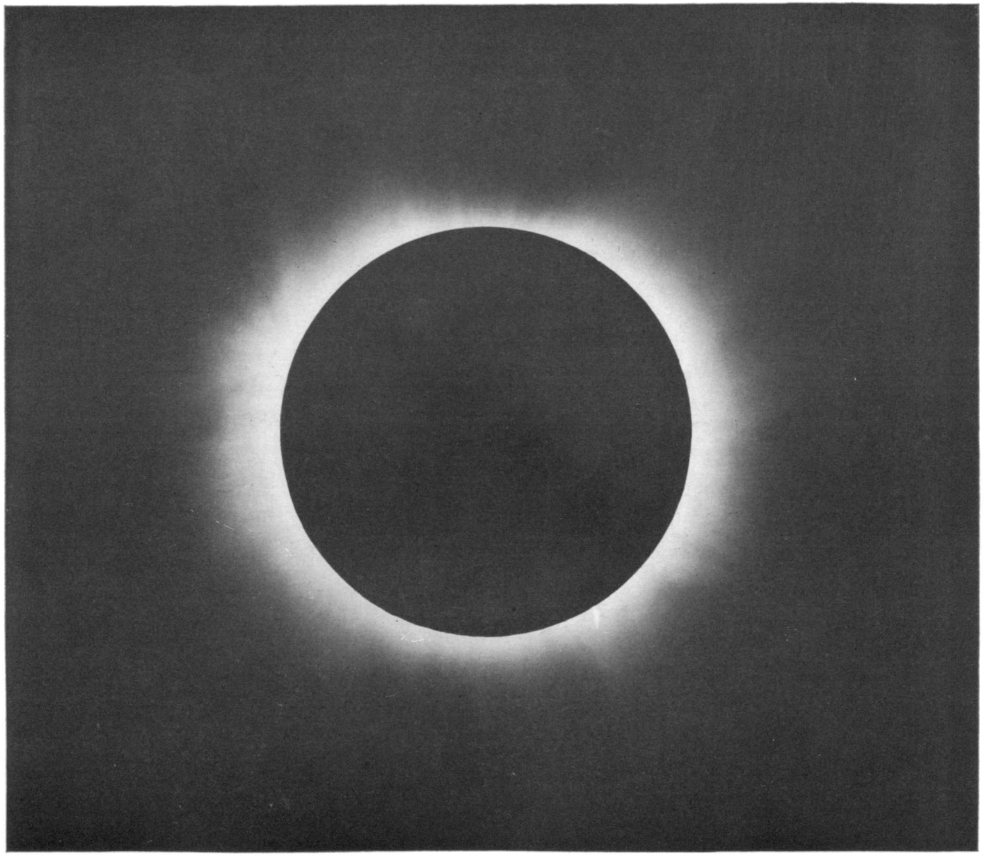

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THE SOLAR CORONA.
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